

SOUTHEAST ISLAND ----- March 13, 1964 ----- (Walker)

Total counted -----	:	22	<u>Numbered tags</u>	
Total adults counted -----	:	11 (50 %)	# 128	Unclassified
Total subadults counted -----	:	11 (50 %)	126	Unclassified
Total yearlings counted -----	:	0	129	Unclassified
Total pups counted -----	:	0	113	Female subadult
Total males counted -----	:	11 (61 %)	26	Female subadult
Total females counted -----	:	7 (39 %)		
Adult males counted -----	:	5		
Adult females counted -----	:	5		
Subadult males counted -----	:	6		
Subadult females counted -----	:	2		

NORTH ISLAND ----- NOT VISITED -----GRASS ISLAND ----- March 14, 1964 ----- (Walker)

TOTAL counted -----	:	27	<u>Numbered tags</u>	
Total adults counted -----	:	15 (55 %)	# 110	Subadult female
Total subadults counted -----	:	12 (45 %)	94	Adult unknown
Total yearlings counted -----	:	0		
Total pups counted -----	:	0		
Total males counted -----	:	12 (67 %)		
Total females counted -----	:	6 (33 %)		
Adult males counted -----	:	3		
Adult females counted -----	:	3		
Subadult males counted -----	:	9		
Subadult females counted -----	:	3		

SEAL ISLAND ----- March 14, 1964 ----- (Walker)

Total counted -----	:	17	<u>Numbered tags</u>	
Total adults counted -----	:	8 (47 %)	# 163	Subadult female
Total subadults counted -----	:	9 (53 %)		
Total yearlings counted -----	:	0		
Total pups counted -----	:	0		
Total males counted -----	:	8 (57 %)		
Total females counted -----	:	6 (43 %)		
Adult males counted -----	:	4		
Adult females counted -----	:	1		
Subadult males counted -----	:	4		
Subadult females counted -----	:	5		

KITTERY ISLAND ----- March 14, 1965 ----- (Walker)

Total counted -----	:	38	<u>Numbered tags</u>	
Total adults counted -----	:	25 (66 %)	# 83	Adult male
Total subadults counted -----	:	13 (33 %)	149	Subadult male
Total yearlings counted -----	:	0	125	Subadult female
Total pups counted -----	:	0	137	Subadult female
Total males counted -----	:	15 (53 %)		
Total females counted -----	:	13 (47 %)		
Adult males counted -----	:	11		
Adult females counted -----	:	9		
Subadult males counted -----	:	4		
Subadult females counted -----	:	5		

SAND ISLAND ----- March 14, 1964 ----- (WALKer)

Total counted -----:	7		<u>Numbered tags</u>
Total adults counted -----:	2	(29 %)	# 131 Adult female.
Total subadults counted -----:	5	(71 %)	
Total yearlings counted -----:	0		
Total pups counted -----:	0		
Total males counted -----:	4	(80 %)	
Total females counted -----:	1	(20 %)	
Adult males counted -----:	1		
Adult females counted -----:	1		
Subadult males counted -----:	3		
Subadult females counted -----:	0		

BIRD ISLAND ----- March 14, 1964 ----- (Walker)

Total counted -----:	3		<u>Numbered tags</u>
Total adults counted -----:	0		None
Total subadults counted -----:	3		
Total yearlings counted -----:	0		
Total pups counted -----:	0		
Total males counted -----:	0		
Total females counted -----:	1		
Adult males counted -----:	0		
Adult females counted -----:	0		
Subadult males counted -----:	0		
Subadult females counted -----:	1		

NEW (PLANETREE ?) ISLAND ----- March 14, 1964 ----- (Walker)

Total counted -----:	7		<u>Numbered tags</u>
Total adults counted -----:	6		None
Total subadults counted -----:	1		
Total yearlings counted -----:	0		
Total pups counted -----:	0		
Total males counted -----:	5		
Total females counted -----:	1		
Adult males counted -----:	4		
Adult females counted -----:	1		
Subadult males counted -----:	1		
Subadult females counted -----:	0		

Totals for all islands visited (Southeast, Grass, Seal, Kittery, Sand, Bird, Planetree (?))

Total counted -----:	121		
Total adults counted -----:	67	(55.4 %)	
Total subadults counted -----:	54	(44.6 %)	
Total yearlings counted -----:	0		
Total pups counted -----:	0		
Total males counted -----:	55	(61.1 % of 90 sexed)	
Total females counted -----:	35	(38.9 % of 90 sexed)	
Adult males counted -----:	28	(70.0 % of 40 adults sexed)	
Adult females counted -----:	20	(30.0 % of 40 adults sexed)	
Subadult males counted -----:	27	(62.8 % of 43 subadults sexed)	
Subadult females counted -----:	16	(37.2 % of 43 subadults sexed)	

Seal Observations on Pearl and Hermes
June 1963

Report states that "records were kept on the numbers of turtles and seals present."

Southeast June 18-22. FSS summary - Seals, very few (6-8 a day) seen--tag numbers difficult to read--several recorded.

June 18 - FCS - Circled island picking up fish balls--dead albatross bands and banded seals.

June 18 - ABA - This morning...walked around the island and only counted two seals. (IGB:) 18 June: #80, #106, either 86 or 98, + 4 other east - 5 on west) 19 June: seal 141 22 June: 113, 92.

Little North June 23 - FCS - 13 seal pups seen.

June 25 - FCS - found 3 tagged seals.

(IGB:) 23 June: seals: 127, 93 with pup, 13 pups

25 June: seal tags 104, 127, 93.

North June 23 - FCS - No mention

June 24 - FCS - Binion took seal count

June 23-25 - FCS Summary:- several with tags recorded. 13-15 pups on island.

June 23 - ABA - I went around the island counting the seals. There were ____ on the beach (____ adults and pups). ICB: 23 June: seal - tagged - 101. 24 June: seal - 71.

Kittery June 26 - FCS - No mention.

SEAL June 26 - FCS - No mention

IGB: seal - 124, 92 - 25+

Grass June 26-27 - FCS Summary - 8-10 seals seen each day

IGB: 134

ABA = Arthur Binion Amerson, Jr. - field notes
FCS = Fred C. Sibley - field notes
IGB = Intermediate sized Green record book

Seal Tags from Kure Atoll

Return Data

Tagging Data

<u>No.</u>	<u>Date Seen</u>		
339	23 April 1966	Green Island	A♀ 6-6-64 Kure
377 w pup	9 May 1966	Green Island	A♀ 3-16-65 Kure
371	9 May 1966	Green Island	A♀ 2-14-65 Kure
370 w pups	9 May 1966	Green Island	A♀ 1-15-65 Kure
274	9 May 1966	Green Island	A♀ 10-18-63 Kure
354	3 August 1966	Sand Island	A♀ 1-15-65 Kure
362	3 August 1966	Sand Island	SA♀ 1-15-65 Kure
404	3 August 1966	Sand Island	A♀ 4-12-65 Kure
38	25 August 1966	Sand Island	A♀ 1-14-63 Lisianski
399	9-12 February 1967	Green Island	Pup♀ 3-10-65 Kure

Table 1. Other Observations of Hawaiian Monk Seals at Kaneohe

Period of Observation	No. Seen	Remarks and References
1915	10	"A large number of hair seals were hauled out on the beach, most of them being asleep." (Munro, 1915)
1934	23 June	50-60 Seen on the island (Baylis, 1934 ms.)
1977	2 March	Seals seen on beach. (Baylis, 1977 ms.)

Table — . Other Observations of Hawaiian Monk Seals at Pearl & Hermes Reef

<u>Period</u>	<u>Island</u>	<u>Island</u>	<u>No.</u>	<u>Remarks and References</u>
<u>Survey</u>		<u>Visited</u>	<u>Seen</u>	
1916 4 Feb.	Seal		15-20	"... many seal found hauled out on the island... several cows with pups [were seen]... One mother... rolled clumsily over [her pup] and crushed the life out of it. The full grown seals were about eight feet in length and weighed close to four hundred pounds each." (Munro, 1916 ms.)
1916 4 Feb.	Grass			"Seals were found... some of them with young (Munro, 1916 ms.)
1916 4 Feb	Southeast		15	" 15 Fifteen seals were occupying the island... There were no young pups among them." (Munro, 1916 ms.)

Table . Numbers of Hawaiian Monk Seals Tagged in the Northwestern Hawaiian Islands.

		No. tagged on each atoll																													
Island Tagged	Period	Laysan					Lisianski					P. and H. Reef					Midway Kure					Total for Tagging Period					Tagged By				
		Ad	Sb	Yr	P	Tot	Ad	Sb	Yr	P	Tot	Ad	Sb	Yr	P	Tot	Ad	Sb	Yr	P	Tot	Ad	Sb	Yr	P	Tot					
1957	June-July	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Woodward				
1958	May-June	—	—	—	—	—	?	?	?	?	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Woodward				
1963	Feb-March ²	—	—	—	—	—	9	0	16	1	26	13	0	20	1	35 ²	74	0	19	0	94 ²	—	—	—	—	—	PRBSP				
1965	Sept.	1?	?	?	?	8	?	?	?	?	11	?	?	?	9	15	>1?				>4?	>19?	—	—	—	—	?	?			
1967	March	?	?	5?	13?	25?	0	2	11	20	33	0	2	15	10	27	0	3	6	1	10	—	—	—	—	—					
	May-June	—	—	—	—	—	0	0	0	12	12	0	0	0	7	7	0	0	0	5	5	—	—	—	—	—					
	Sept.	1	3	8	0	13	2	9	6	0	23	7	1	11	0	19	9	1	8	0	18	—	—	—	—	—					
1968	March	No data available																													
	Aug-Sept																														
1969	March	No data available																													
	May																														
	June																														
	May	—	—	—	—	—	0	2	7	29	38	0	1	3	14	18	0	0	0	0	0	—	—	—	—	—	0	3	10		
	June	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	15	15	—	—	—	—	—	—	0	0	0	

1. Dashes mean that island was not visited during tagging period or that no seals seen at Islands visited.
 2. Includes one of unknown age & sex.
 3. See attached sheet - 6. listed as 2 yr. animals

7. Report says that 18 pups were banded but list of animals tagged includes 14 pups, 3 yearlings, and 1 1-2 yr. old.
 3. Subadult as a two year old. Comment also made that "majority of those listed as yearlings were probably large pups but a few were yearlings I'm sure."
 4. One of these was a retagging of A 119

Two Monk Seal Skulls - from Leeward's
cruise.

Sent from Hono to DC Summer 1967
probably in a frozen shipment:

Collected on Laysan Island, June 11, 1967,
by R. DeLong.

(This is collecting data that might not be with skulls or
in any catalog. - should be on skull labels)

you tried to tag all individuals using the
Kure bands.

Therefore, if they did not mix randomly
through the population (i.e. if each individual
tended to exclusive use), you should sight
an excessively high percentage of marked
individuals. You didn't, so your estimate tends
to be conservative. Your evidence for low
mortality & good retention of tags is
persuasive.

So I would guess that your estimates
tend to be low unless one can postulate some
odd behavior. For example, if the experience
of being tagged tended to cause a seal to
leave that island, this would cause you to
overestimate. I think your data can pretty
well rule this out as an important factor.

These points might be worth mentioning.

63-5-1

Comments on "Population dynamics and inter-island
Movement of the Hovon Mank Seal." Warty

- P2 What is the basis for differentiating subadults as those between 45 and 90 Kg? Why were metric units used here, when all other measurements in the paper are in English units?
- P3 Why were subadults lumped with adults for all discussions?
- P4 "adjustments" of figures difficult to follow.
- Table 2 - Probably too long for journal publication.
- P5 Suggest putting all numerical data for inter island movements on one figure (see attachment) with shorter discussion.
- P6 "Adult mortality" section contains far more information on injuries than on mortality.
- P8 - Discussion of populations should follow info. given on populations in the "Results" section. "Results" section could be called "Results & Discussion."

p 10411 Calculated numbers for the four islands
discussed add up to 6,300, ~~while~~ although the
world population is estimated as 13,500.
Some indication should be given as to where
the other 7,200 seals might be found.

Philip C. Shelton,

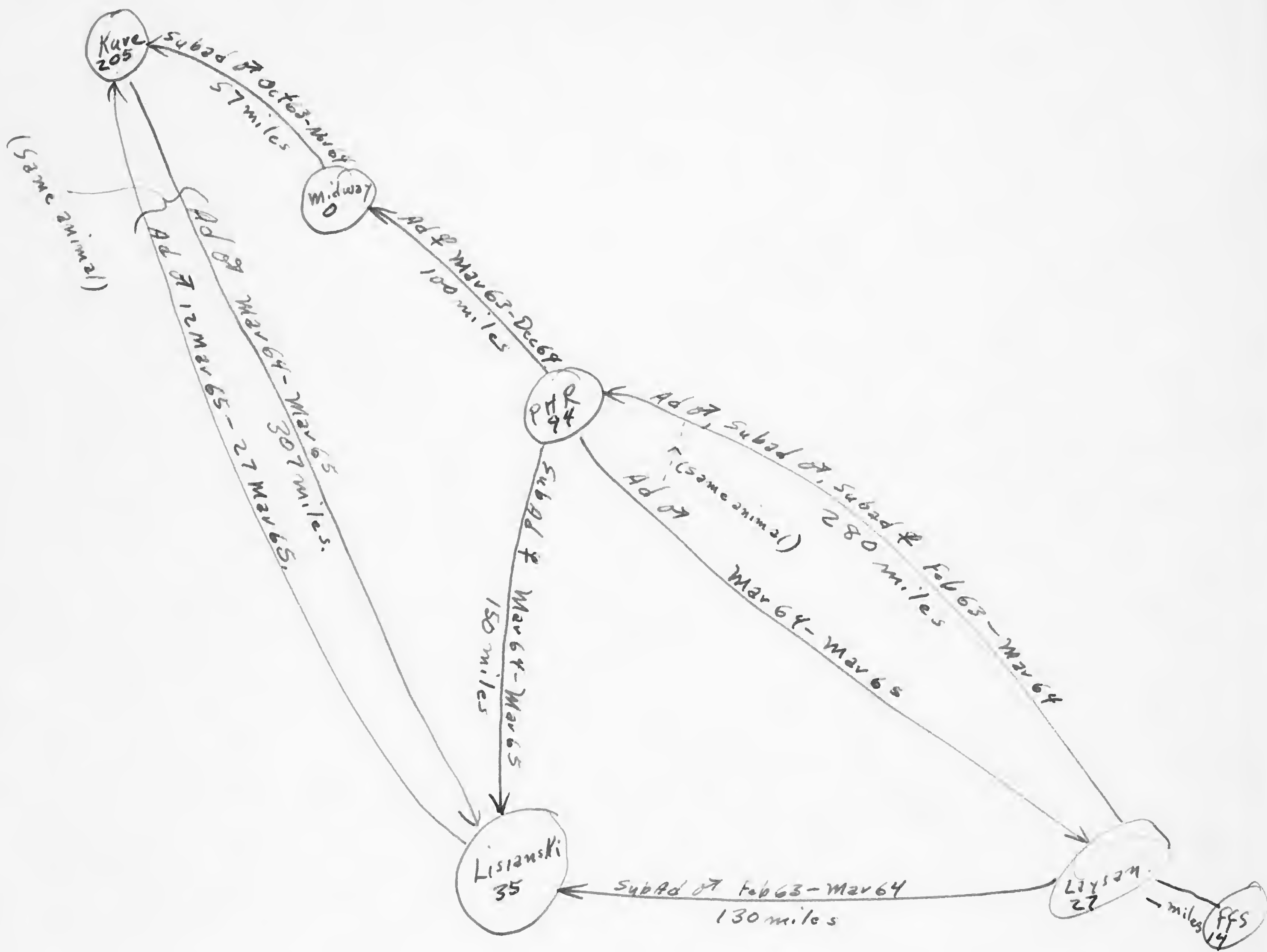


FIG. 5 Inter-Atoll Movements of Hawaiian Monk Seals, Hawaiian leeward islands, 1963-1965.

Monk Seal References

Bailey, A.M.

1918. The monk seal of the southern Pacific. Nat.Hist., 18: 396-399

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1959. Life history of the Hawaiian monk seal. Pac.Sci., 13:215-252.

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Rice Dale v.

The Hawaiian Monk Seal

Natural History 73(2): 48-55

February 1964

File

SPECIAL REPORT

CENSUS AND OBSERVATIONS OF HAWAIIAN MONK SEAL

on

Pearl & Hermes Reef, Lisianski and Laysan Islands

May 31 to June 11, 1967

Prepared by

by

Robert DeLong

Leewards Cruise #19

Census and observations on Hawaiian Monk Seal Monachus schauinslandi, Pearl & Hermes Reef, Laysan and Lisianski Islands, 31 May - 11 June 1967

A minimal amount of time was devoted to the seal surveys. On Pearl & Hermes the surveys were taken during the first day on the islands, but on Laysan and Lisianski the surveys were made on the last day of the visit. Thus, due to disturbance, counts on the latter islands are low. Counts on Pearl & Hermes and Lisianski do not completely distinguish between pups in postnatal pelage and yearlings. The failure to distinguish between these two age classes was caused by finding tagged animals of both age groups carrying tags of the same numerical series. It was first assumed that all had been tagged as pups and thus were the same age, but this later proved to be false. For some of these animals sufficient notes were taken at time of observation to later distinguish between the age groups.

Twenty-four pups in natal pelage were tagged on the islands visited (Table 5) and 21 returns were taken (Table 4). Two skulls were obtained from dead, putrified adults on Laysan Island. An additional dead adult was seen on Laysan.

DISCUSSION

The discussion is primarily an extension of K. C. Balcomb's report on Monachus prepared after the June 10-22, 1966, visit to Laysan and Lisianski Islands.

Feeding and Hauling Behavior

Rice (1964) noted that on moonlight nights there were only adult females with pups on the beach. He concluded from this and other evidence that the animals feed at night. During Balcomb's surveys and again on this survey we noted many adults on the beach at night. Our visits were primarily during periods of dark moon. During dark-moon periods, the animals probably feed in the early mornings while the scattering layer is still near the surface in pelagic waters, and food species on the reef are out of hiding.

On 7 June during our stay on Lisianski, a storm blew up with heavy winds from the northwest. During the day and night that this blow continued, seals hauled out on the beach far back into the Scaevola fringe. Some of these animals were noted at different times during the night of 6-7 June, and again throughout the day of 7 June (except for a period when the survey party left the island) and again on the night of 7 June. During this entire time, many of the animals stayed in the Scaevola fringe, not leaving until early morning on 8 June (presumably to feed). Do these animals commonly refrain from feeding over long periods during the winter

when the seas are stormy? One other marine mammal, the Sea Otter in the Aleutians, undergoes extended periods without feeding in the winter months due to heavy seas.

Also on Lisianski a group of nine loosely associated adult and sub-adult males were hauled-out on the sandy beach near the water.

REPRODUCTION

One pup was born on Laysan Island on 10 June. The umbilical cord was still connected to the pup, but there was no sign of the placenta. The pup was still wet with amniotic fluid. The female made no effort to lick the pup. Two other gravid females were seen on Laysan Island; one was seen on Lisianski.

Again the Laysan Island survey shows a disparity between the ratio of male and female pups (Table 3). There were 10 male pups (in natal pelage) and only one female. Although the ratio is closer in older pups (those in post-natal pelage), there are still 125% more males than females. No such large disparity in the sex ratio was noted on the other islands. No explanation is offered at this time.

GENERAL

Similarities between Monachus and the Northern Elephant Seal (Mirounga angustirostris) were pointed out by Balcomb. However, he failed to note one important dissimilarity in the behavior of the two species when comparing reproductive rates of the two animals. The elephant seals have complex harem behavior, whereas the Hawaiian Monk Seal apparently has none. The danger of comparing reproductive rates is that in the elephant seal there is an exchange of parental duties between the bulls and cows. The following comes from discussion of elephant seals with Dr. Carl L. Hubbs: The month of March was known to the sealers as "the month of the big bulls" in California and Mexico. During that time cows go to sea to feed and rest and the bulls remain on shore. Then in April, and at least early May, the cows return to the islands and the bulls go to sea.

Balcomb noted circular bites on immature Hawaiian Monk Seals and suggests that they may have been inflicted by moray eels. He notes further that similar bites are common on elephant seals on islands off Baja, Mexico, but states that moray eels are not found there. The latter is not true. On the recent SIO Marine Vertebrate Cruise to Guadalupe Island a lobster trap was set just offshore Guadalupe Island. When pulled this trap was filled with moray eels. I think that these circular scars, which look much like gun wounds, may indeed be caused by moray eels in both species in their respective geographical locations.

Initial survey on 7 June yielded a total (without breakdown) of 13 monk seals on the beach. When the complete count was taken on 11 June,

after four days and nights of disturbance, only 89 animals were counted, representing a 32 percent drop in the population on Laysan Island. Some of this was undoubtedly due to disturbance. If possible, the seal surveys should be taken during the first day on the island.

REFERENCES

Balcomb, Kenneth C. 1966. Summary Report on the Status of The Hawaiian Monk Seal, Monachus schauinslandi, Laysan and Lisianski Islands, 10-22 June 1966, Preliminary report, Pacific Ocean Biological Survey Program, Smithsonian Institution, (Not published).

Rice, Dale W. 1964. The Hawaiian Monk Seal. Natural History 73(2): 48-55, February 1964.

TABLE 1. Monachus schauinslandi Survey, Pearl & Hermes Reef,
28 May (Southeast), 31 May (other islands), 1967

Category	Southeast	Bird	Grass	Seal	Kittery	Total
Adults, counted	13	5	12	11	17	58
" male	3	2	4	2	14	
" female	7	-	4	7	1	
" undetermined	3	3	4	2	2	
Immatures*, counted	7	2	-	1	3	13
" male	1	1	-	-	2	
" female	2	1	-	1	1	
" undetermined	4	-	-	-	-	
Pups (natal pelage)						
" counted	1	-	1	6	-	8
" female	1	-	-	3	-	
" undetermined	-	-	1	-	-	
male				3		
	<u>21</u>	<u>7</u>	<u>13</u>	<u>18</u>	<u>20</u>	= <u>79</u>

* Immature includes both pups in post-natal pelage and yearlings.

TABLE 2. Lisianski, Monachus Survey, 6 June 1967Category

Adults, counted	87	
" male		37
" female		42
" undetermined		8
Subadult, counted	18	
" male		9
" female		7
" undetermined		2
*Immature, counted	11	
" male		3
" female		6
" undetermined		2
Pup (postnatal), counted	3	
" male		1
" female		2
" undetermined		-
Pup, natal pelage, counted	9	
" male		3
" female		5
" undetermined		1
	128	128

Thirty of the above adults were paired.**
 Two of the natal pups were unattended.**
 Three of the adult females were gravid.**

*Immature includes both post natal (silver) pelage pups and yearlings.

TABLE 3. Laysan, Monachus Survey, 11 June 1967

Category

Adults, counted	46	
" male		15
" female		19
" undetermined		12
Subadult, counted	9	
" male		1
" female		7
" undetermined		1
Yearling, counted	7	
" male		5
" female		-
" undetermined		2
Post-natal pups, counted	15	
" male		9
" female		4
" undetermined		2
Natal pups, counted	12	
" male		10
" female		1
" undetermined		1
	<u>89</u>	<u>89</u>

Twenty-six of the above adults were paired.*
 One natal pelage pup was unattended.*
 One pup was born on 10 June.*

* Included in the above table.

TABLE 4. Returns on Monachus schauinslandi, Leeward Island Cruise #19
May, June 1967

Pearl & Hermes Reef

	Island recaptured	(Date captured)	Island of origin	Date Tagged	Status
569	Southeast Island	28 May '67	Southeast	09-21-66	M pup
532	"	"	Lisianski	09-19-66	F pup
584	"	"	Southeast	09-24-66	M sad.
582	"	"	"	"	M ad.
579	"	"	"	"	M pup
A66	Kittery	31 May	Lisianski	03-20-67	M yr.
A101	"	"	Kittery	03-22-67	M yr.

Laysan

A37		10 June	Laysan	03-19-67	M pup
A39		"	"	"	M pup
A43		"	"	"	F pup
A46		"	"	"	M pup
A48		"	"	"	M yr.
A59		"	"	"	F pup
A61		"	"	"	F pup
A63		"	"	"	F pup

Lisianski

540		6 June	Lisianski	09-19-66	F pup
522		"	"	"	M pup
A71		"	"	03-21-67	F yr.
A75		"	"	"	F yr.
A77		"	"	"	M pup
A78		"	"	"	F pup

TABLE 5. New Taggings, Hawaiian Monk Seals, May, June 1967
Pacific Program, Smithsonian Institution

Seal Island, Pearl & Hermes Reef, 28 May 1967

A 102	female pup (black pelage)	
103	male	" "
104	"	" "
105	female	" "
106	"	" "

Lisianski Island, 6 June

A 107	male pup (black pelage)	
108	female pup	"
109	"	"
110	male	"
111	female	"
112	male	"
113	female	"

Unaccompanied* Unaccompanied*

Laysan Island 10 June

A 114	male pup (black pelage)	Unaccompanied*
115	female pup	"
116	male pup	"
117	"	"
118	"	"
119	"	"
120	"	"
121	"	"
122	"	"
123	"	"
124	"	"
125	" (SILVER PUP)	

* All other pups attended (accompanied) by female.

SJC 13

SUMMARY REPORT ON THE STATUS OF THE
HAWAIIAN MONK SEAL, Monachus schauinslandi
LAYSAN AND LISIANSKI ISLANDS 10 - 22 JUNE, 1966

by

Kenneth C. Balcomb III

for

Pacific Ocean Biological Survey Program

SUMMARY REPORT ON THE STATUS OF THE
HAWAIIAN MONK SEAL, Monachus schauinslandi
LAYSAN AND LISIANSKI ISLANDS 10 - 22 June, 1966

Pacific Project personnel visited Laysan and Lisianski islands during June of 1966 to survey vertebrate populations and band the maximum possible number of nesting seabirds. As part of the former objective, a census was made of all monk seals present on the islands during our visit. The following is a report based on that census.

METHODS:

On Laysan island, a large part of the vertebrate census was accomplished between the hours of 1000 and 1500 on 10 June by the seven members of the field party walking around the island regularly spaced between the island's central lagoon and the peripheral beaches. Balcomb and Phil Shelton surveyed the vertebrate populations along the beach and Scaevola taccada fringing the beach. On Lisianski island, the seal count was accomplished between 0930 and 1315 on 19 June by Shelton and Balcomb walking around the island along the beach and Scaevola fringe. Additional diurnal and nocturnal observations were conducted on both islands as time permitted. On Lisianski island, we spray painted gold marks on 34 seals to facilitate later observations.

All seals censused were placed in four categories: Adult, Immature, Pup of the year, and Newborn (black pelage.) These categories were further subdivided by sex as male, female, or undetermined sex.

RESULTS: Counts

The data for our seal counts are presented in Table I for both Laysan and

Lisianski islands. From these figures, one can calculate the ratio of adults to pups, immatures to pups, and adults+immatures to pups as presented in Table II. Since approximately 50% of the pups past newborn stage had apparently been weaned, and the mothers returned to sea to feed, an ammended total adult population was calculated to obtain a better view of the adult to pup ratio. This number was calculated by adding to the figure for total adult population the number obtained by multiplying by .5 the total pup of the year figure (not counting newborn.) For purposes of comparing these figures to those for elephant seal Mirounga angustirostris counts made on certain Mexican islands, I have used the counted adult to pup ratio, because in fact, not all the adult animals are present on elephant seal breeding grounds either (most of the adult females are present, but bachelor bulls are excluded.)¹

TABLE I. MONK SEAL POPULATION CENSUS

Category		Laysan		Lisianski		Combined
Adults, counted	123		95		218	
" , male		27		37		64
" , female		38		30		68
" , undetermined		58		28		86
Immatures, counted	51		26		77	
" , male		12		10		22
" , female		15		6		21
" , undetermined		24		10		34
Pup of Year, counted	54		33		87	
" , male		38		14		52
" , female		11		17		28
" , undetermined		5		2		7
Newborn, counted	14		3		17	
" , male		x		x		x
" , female		x		2		2
" , undetermined		14		1		1
Total	<u>242</u>	242	<u>157</u>	157	<u>399</u>	399
Adults, calculated	149		112		261	
Adults, paired male/female	x		16		16	

TABLE II. RATIOS

	A:P ¹	A*:P ²	A+I:P ³	A*+I:P ⁴	I:P ⁵
Laysan	1:0.55	1:0.46	1:0.39	1:0.34	1:1.25
Lisianski	1:0.38	1:0.32	1:0.30	1:0.26	1:1.28
Combined	1:0.48	1:0.40	1:0.35	1:0.31	1:1.26

- 1 Adults counted:Pups of Year counted (includes Newborn)
- 2 Adults calculated (see text): Pups of Year counted (includes Newborn)
- 3 Adults counted + Immatures counted:Pups of Year counted
- 4 Adults calculated + Immatures counted:Pups of Year counted
- 5 Immatures counted:Pups of Year counted

RESULTS: Observations

Hauling out

Monk seals behave unlike most other phocids, with the exception of the elephant seal, in that they will haul out some considerable distance from the waterline, and remain on land in spite of the presence of man in the immediate vicinity. Most of the time spent ashore is occupied by sleeping; the remainder usually moving to a place to sleep. Even when aroused from their sleep, Monk seals seem to be reluctant to move to the relative safety of the water, and will usually return to sleep if left alone. The best method for determining the sex of such animals, if they are not already sleeping on their side or back, is to quietly approach one and nudge it in the side with your foot. The seal generally wakes up quite startled, and makes a rapid roll away from you, either to escape, or to assume the effective protective position of lying on its back striking with hind flippers or head if you come too close. Young seals can be restrained for observation when lying on their back by placing your foot on their chest.

Contrary to the observation of Rice² on Laysan island of only females with pups hauling out in the Scaevola at night, we observed that animals of all age classes moved up into the Scaevola fringing the beach at dusk, and could usually be found there at any hour of the night and sometimes late in the morning. Some animals could be found in the Scaevola throughout the day.

Animals were also seen hauled out on the exposed coral reefs at low tide.

Feeding

The only seals that we saw feeding were nursing pups. There was no apparent regularity in the nursing times. No seals were seen catching or carrying food, and no regurgitated stomach contents were found. Rice² found that at least part of their diet consists of octopus, squid, and eels.

Aggressive behavior

The only animals we observed to exhibit any aggressive behavior were some females with pups, and a few of the adult males that were accompanying females. Most of the animals were quite tame, and, when disturbed, exhibited only the defensive behavior mentioned earlier.

Reproduction

There was no harem formation and no localized rookery formation observed for this species on either Laysan or Lisianski, though the cows with small and newborn pups were primarily on the east and northeast shores(leeward) of both islands. Female Monk seals probably bear young only once every two years, as is evidenced by the fact that approximately 50% of the adult females have not had , and apparently will not have a pup this season. Many of these females were paired with adult males at the time of our count. No copulatory behavior was observed for this species during our visit.

Probably the Monk seal is monogamous, as some males showed strong protective instincts for the accompanying female and remained with her on land and in the water. In one instance, an adult male seal came out of the water to the aid of one female with a newborn pup that we were examining.

There were many very plump pups on both islands that had apparently been weaned recently, or were being weaned, as the mother was not in the vicinity.

We saw several very young (one to two day old) pups with their enormously fat mothers, and at least two heavily gravid females that should give birth very soon. This indicates to me that the pupping season began in early spring, and is continuing through the present.

Mortality

Three dead adult seals were found on Laysan island during the survey. Two were in a very advanced state of decomposition. Sex was undeterminable on all three specimens. One skull was collected. On Lisianski, two skulls were collected, one from a decomposing pup or immature, the other was found lying on the beach.

Sharks spawning in the vicinity of Laysan island did not appear to bother the seals swimming in the same area. Several adult seals had enormous scars on their back, and one adult male hauled out on the beach at Laysan had a large deep gash across his back just in front of the hind flippers. Several older pups of the year were seen to have large circular back wounds (4" diam. x 2" deep) that might have been inflicted by octopus or squid, or even moray eel (I have seen almost identical scars on young elephant seals in areas where there are no moray eels.) The severity of these wounds indicates that there must be at least some mortality as a result of whatever the wound-inflicting agent may be.

The fact that there are 26% more pups than all subadult animals older than this year's pups, indicates that either the population is growing, or, if the population is stable, approximately 20% of the pups of the year do not survive to the following year. The latter seems to me to be the case.

Note on counting seals

We spray painted gold marks on 34 seals on Lisianski island during the course of our counts, and four times observed painted seals hauled out on beaches which we had not yet counted. This indicates a possible source of inaccuracy

if one does not somehow keep track of seals that have already been counted. (in the course of painting an animal, it usually sought the water, thus increasing the chance that it might haul out elsewhere.)

No seals were observed at sea. Virtually nothing is known about the relative amount of time spent at sea, or the distances traveled by this species.

COMPARISON TO ELEPHANT SEAL, Mirounga angustirostris:

The ratios in Table II of Adults to Pups, and Immatures + Adults to Pups show some striking similarities to comparable ratios found for the Northern elephant seal on rookery and hauling out areas on certain Mexican islands. For example, when the figures for Laysan of Adults+Immatures:Pups are compared with similar figures for elephant seals on hauling out and rookery areas (adults, immatures, and pups) on Isla San Benito del Oeste, we find that the ratios are identical - 1:0.39.³ Likewise, the ratio of adult monk seals:pups (1:0.55) is almost identical to that of adult elephant seals to pups on the rookery areas (adults and pups only) on the northeast shore of Guadelupe island (1:0.57.)³ The ratios for Lisianski island do not come as close, but the ratio for Laysan and Lisianski combined (1:0.35 and 1:0.48 respectively) do come significantly close to those for elephant seals. Both species have made a comeback from near extermination by sealers in the 19th Century. The elephant seal population on the before-mentioned islands appears to be leveling off after a half-century of repopulation.³ Is the monk seal population on these islands doing the same thing? Rice observed approximately 300 monk seals on Laysan in the summer of 1957, essentially the same as our count of 242 this June.² The monk seal could very well be at its optimum population level right now.

Behaviorally and morphologically, the monk and elephant seals are very similar. I think that, in all likelihood, data and observations obtained from

one species can be very valuable in understanding the other species.

SUMMARY:

In June of 1966, Pacific Project personnel counted a total of 242 monk seals on Laysan island, and 157 monk seals on Lisianski island. On both islands there were pregnant animals, and many pups in all stages, from newborn to weaned, indicating that the pupping season began in the early spring and is continuing through the present time. Monk seal populations on both islands may have leveled off to the optimum for the area. Comparisons are made to elephant seal populations on certain Mexican islands.

Footnotes:

1. Personal observation.
2. Rice, D.W.
1964 The Hawaiian Monk Seal. *Oryx*, vol. VII, no. 6:295-300.
3. Rice, D.W., K.W. Kenyon, and Daniel Lluich B.
1965 Pinniped populations at Islas Guadalupe, San Benito, and Cedros, Baja California, in 1965. *Trans. San Diego Soc. Nat. Hist*, vol 14, 7:73-84.

Population Dynamics and Inter-atoll Movement
of the Hawaiian Monk Seal

William O. Wirtz, II

ABSTRACT

Monk seals were tagged and censused in the Leeward Hawaiians between February 1963 and July 1965. Most of the work was done at Kure Atoll. A total of 375 seals was tagged, 56 of them known age pups, and 1997 subsequent sightings were recorded for the subadult and adult individuals. Adult mortality is apparently low. Numbers of seals on the beach fluctuate irregularly. Only 10% of the total tagged seals were observed per census. Approximately 47% of the seals observed in a given month were not seen in the previous month. Limited inter-atoll movements of up to 300 miles are documented. The size of the population utilizing a given island at a given time may be from two to ten times the number counted on the beach.

INTRODUCTION

The Hawaiian monk seal, Monachus schauinslandi, is restricted in its distribution to six atolls in the Leeward Archipelago of the Hawaiian Islands. The total population is presently estimated at 1350 individuals (Rice, 1960). Because of the inaccessibility of its natural habitat relatively little has been published concerning the biology and ecology of this species.

The Pacific Ocean Biological Survey Program of the Smithsonian Institution began tagging monk seals in early 1963 as one aspect of an ecological survey of the Leewards. Between September 1963 and August

1965 the Survey maintained an ecological research station on Green Island, Kure Atoll ($28^{\circ} 2' N$ Lat, $178^{\circ} 1' W$ Long). During this period information was collected concerning population dynamics, movements, and behavior of the monk seal.

METHODS

Monk seals were tagged in the web of the left hind flipper with a yellow nylon, rivet-style, cattle ear tag supplied by the National Agricultural Supply Company. The tags had black numerals imprinted on the male portion and return information on the female portion. Seals were physically subdued by two or three men using rope nooses or a large tarpaulin while the tag was fastened with special pliers. Efforts were made to tag all the animals which used Kure Atoll in late 1963 and early 1964. On other islands seals were tagged whenever time permitted. Most of this tagging was done in 1963.

Age, sex, date, and exact locality were recorded for each newly tagged animal. Any additional information, such as injuries, foods, presence of young, association with other individuals, or behavior, was also recorded. The dates and localities of subsequent sightings, plus any relevant data, were added to the record kept on each seal.

Seals were counted on the beach at each island each time the island was visited, normally on the first day of the visit before anyone had passed along the beach, so that the counts obtained would be natural for that time of day, season, and weather conditions. Time limitations did not permit sexing of individuals, but pups in black pelage, subadults of mature pelage but weighing between 45 and 90 kg, and adults were differentiated.

At Kure seals were counted on the beaches of Green Island at intervals of one to two weeks, and occasionally more frequently, between October 1963 and July 1965. The 3.5 mile beach was marked at 100 yard intervals so that individuals could be quickly located with reference to these markers. In addition to these regular censuses Survey and Coast Guard personnel frequently walked portions of the beach, gaining additional information from tagged seals.

RESULTS

Populations - The distribution by age, sex, and locality of the 375 seals tagged by the Survey is presented in Table 1. The majority of these animals, 149 adults or subadults (hereafter referred to as the adult group), and 56 pups, were tagged at Kure Atoll, and 94 adult group seals were tagged at Pearl and Hermes Reef ($27^{\circ} 4' \text{ N Lat}$, $175^{\circ} 4' \text{ W Long}$). All but three of the pups tagged at Kure are known age animals.

Nine of the adult group tagged at Kure were seen only in the month they were tagged, but four of these animals were not tagged until March 1965. There are 1929 subsequent observations available on the remaining 140 animals, including two subsequently found on other atolls in the Leewards. A maximum of 62 observations is available for one individual, but some were seen only once subsequent to tagging.

Between October 1963 and July 1965 Survey personnel made 70 counts of the seals present on the entire beach at Kure (Table 2). These counts normally took about two hours, and every effort was made to avoid frightening animals off the beach so that they would not be counted a second time. In addition there were 13 counts of the seals on the sandspits

Table 1: Distribution by age, sex, and locality of tagged monk seals. Numbers used on each island are given as reference for future workers. Broken tags which were not put on animals are not indicated, and are the reason for the discrepancy between the number of seals tagged and the tag numbers listed for each island.

Island	Adult		Subadult			Juvenile			Total	Numbers Used
	♂	♀	♂	♀	?	♂	♀	?		
French Frigate Shoals*		2		7	3			2	14	169 - 182
Laysan Island	5	5	8	6	2	1			27	2-8,10,11, 13 - 31
Lisianski Island	6	4	16	4	4	1			35	32 - 68
Pearl and Hermes Reef	28	27	13	23	3				94	1,9,12, 69 - 168
Kure Atoll	55	78	7	9		24	32		205	200 - 414
Total	94	116	44	49	12	26	32	2	375	

* 23° 5' N Lat, 166° 1' W Long

west of Green Island. All counts are presented graphically in Figure 1. The total number of seals seen, and the number and identity of tagged seals, are available for each count on the main island. By tabulating a running total of the number of adult group animals tagged prior to each census it is possible to calculate the percentage of the tagged adult group seen on any one census (Table 2). The mean percentage of tagged adult group seen during censuses is 9.2 (SD 6.9) (see Figure 2). A chart was constructed to show the months in which each individual was observed (Figure 3). From this chart it is possible to determine the number of different tagged individuals observed in each month. The mean number of different individuals observed for 22 consecutive months is 43.4 (SD 21.5). The mean percentage of the total tagged adult group observed in 40.4 (SD 19.6). The number of different individuals observed during a given month was used instead of the cumulative total of tagged seals to calculate an adjusted percentage of tagged seals observed on any given census, with the assumption that only those seals seen at some time during the month composed the total population of tagged seals for that month (Figure 2). The mean adjusted percentage of tagged adult group seen per census is 23.5 (SD 18.1). The data were examined for population turnover by determining the number of individuals for each month which were observed during the previous month and the number new for the month. The frequency distribution for the percentage of new animals each month is plotted in Figure 4.

Recent population estimates for four Leeward islands are presented in Table 3 with the authority for each census and the date it was made.

Figure 1: Fluctuations in numbers of adult group seals at Kure Atoll. Continuous lines connect census figures from 70 beach counts on the main island. Δ are counts made on the sandspits in 1964, 0 are counts made on the sandspits in 1965.

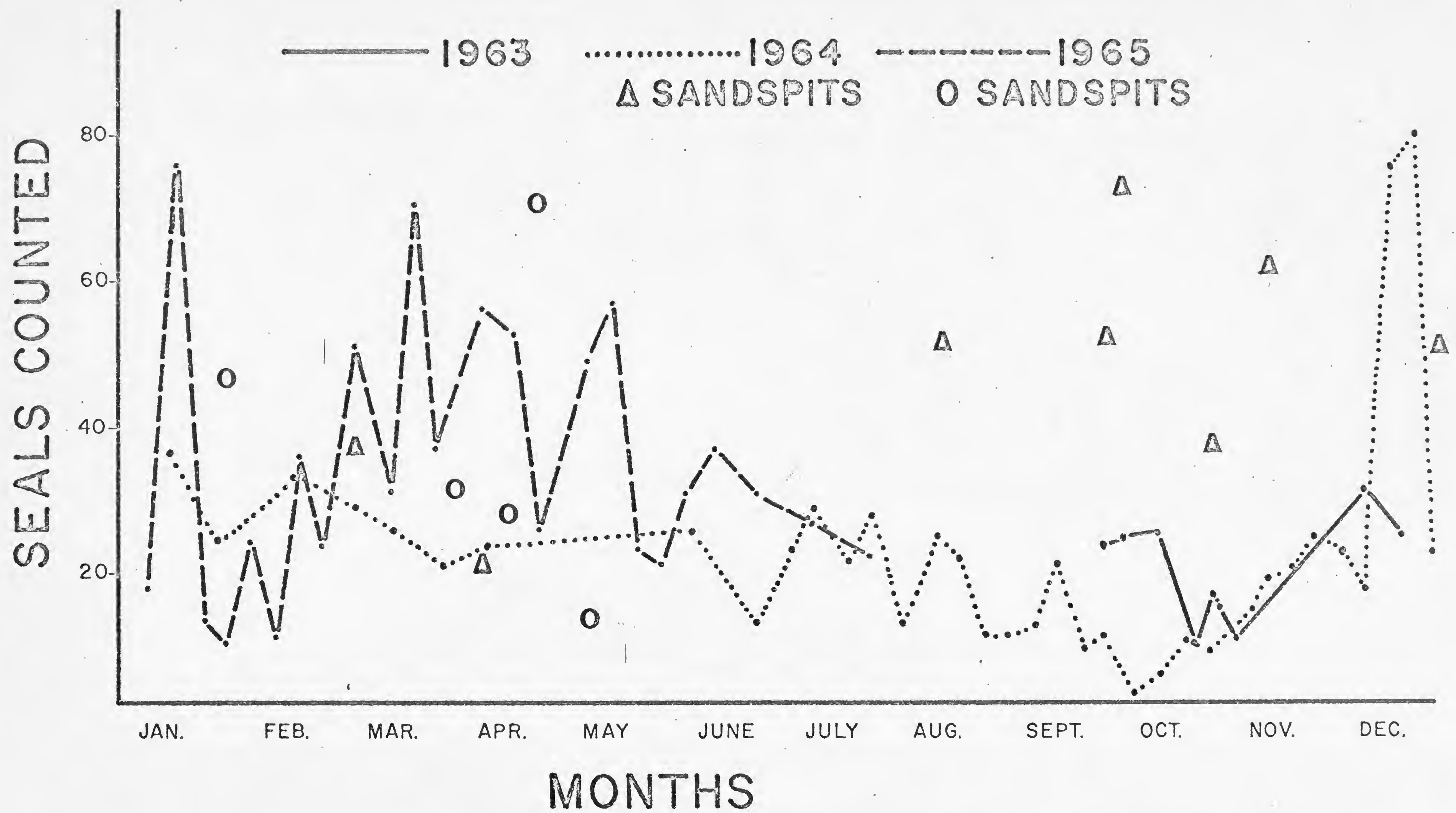
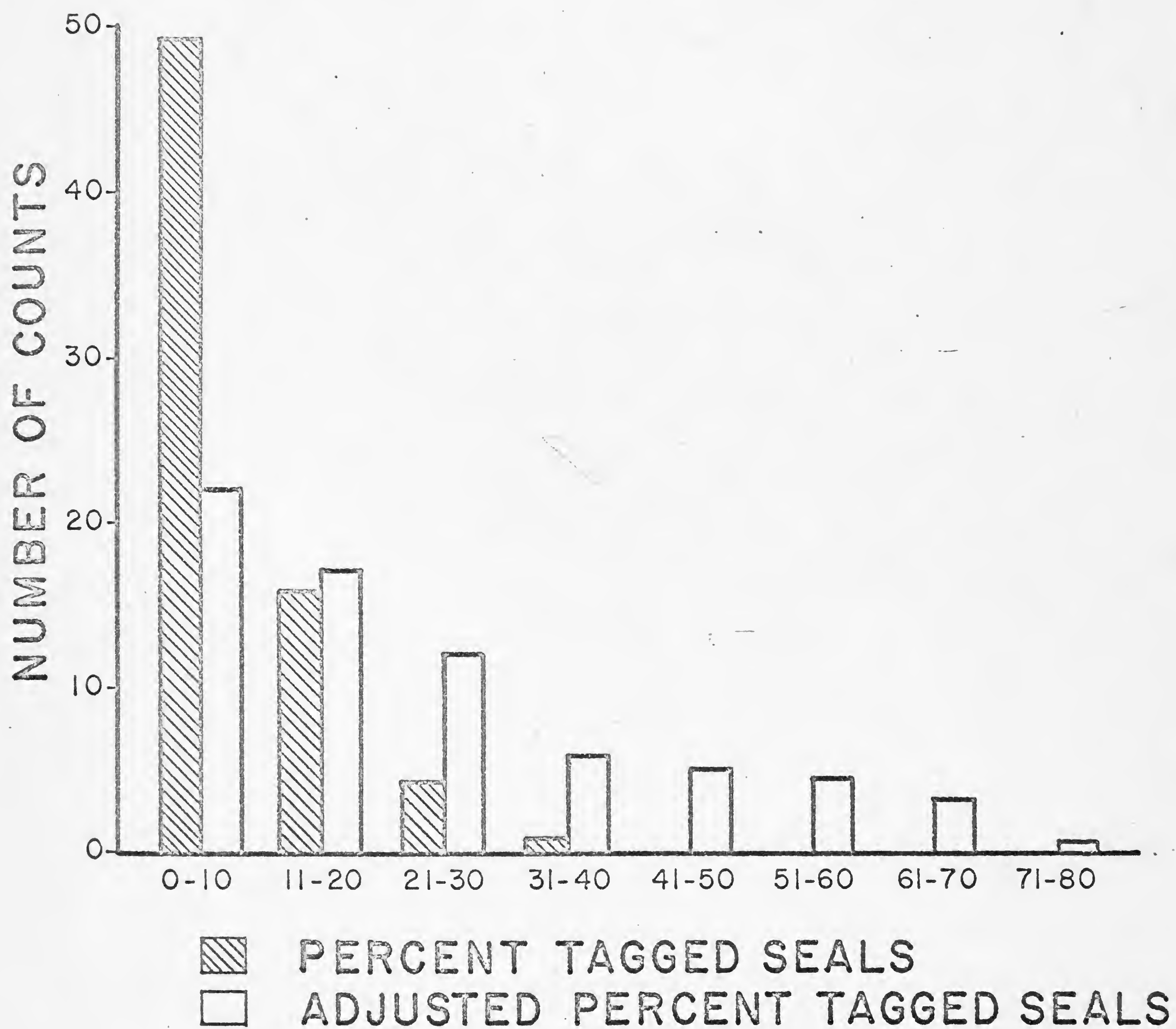


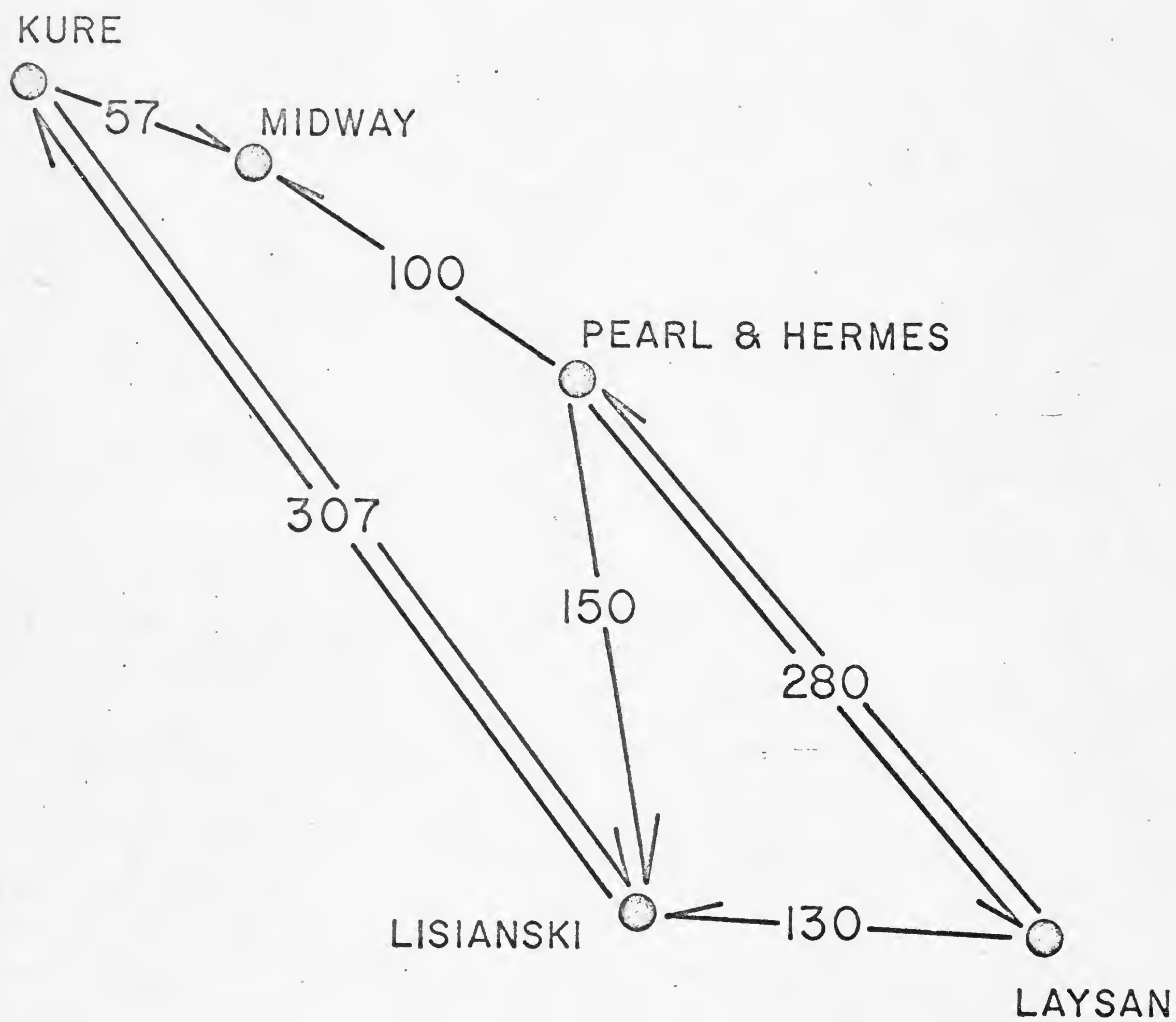
Figure 2: Frequency distribution for percentage tagged adult group and adjusted percentage tagged adult group observed per census. Mean percentage tagged adult group = 9.2 (SD 6.9). Mean adjusted percentage tagged adult group = 23.5 (SD 18.1).



If more than one figure was given for a visit only the highest is presented here. Pup figures are given if the authors indicated that they were counted separately or looked for and not found. Survey counts from Kure are not included.

Inter and Intra-atoll Movement - Eight instances of inter-atoll movement were recorded, including two round trips (Figure 5). Three individuals, an adult male and a subadult male and female, tagged on Laysan Island ($25^{\circ} 4' \text{ N Lat}$, $171^{\circ} 4' \text{ W Long}$) in February 1963 were subsequently reported at Pearl and Hermes Reef, 280 miles to the northwest, all in March 1964. The adult male was found back on Laysan in March 1965. A subadult male tagged on Laysan in February 1963 was found on Lisianski Island ($26^{\circ} 0' \text{ N Lat}$, $173^{\circ} 5' \text{ W Long}$) in March 1964, a move of 130 miles. An adult female tagged at Pearl and Hermes in February 1963 was found at that atoll in March 1964, and then on Lisianski in March 1965. These islands are 150 miles apart. An adult female tagged at Pearl and Hermes in March 1963 was found dead on the beach at Midway Island ($28^{\circ} 1' \text{ N Lat}$, $177^{\circ} 1' \text{ W Long}$), 100 miles to the northwest, in December 1964. There were no apparent external injuries, according to the report received from Navy personnel. A subadult male tagged at Kure in October 1963 and last seen there in March 1964 was seen at Midway, 57 miles east of Kure, in November 1964. This seal was with a second tagged individual whose number could not be read. An adult male tagged on Kure in October 1963 and last seen there in March 1964 was found on Lisianski, 307 miles to the southeast, on 12 March 1965. On 27 March 1965 he was back at Kure.

Figure 5: Inter-atoll movement of monk seals, not drawn
to scale.



INTER - ATOLL
MOVEMENT IN MILES
(NOT TO SCALE)

Only 6 of the 27 seals tagged at Laysan in February 1963 have been subsequently recorded, and only three of these at Laysan, including the male which moved to Pearl and Hermes and back to Laysan. Five of the 35 seals tagged in March 1963 on Lisianski have been subsequently reported on that same island. There are 52 subsequent sightings of 32 different individuals from the 94 seals tagged at Pearl and Hermes in March 1963. Two of these sightings represent inter-atoll movements described above. The remaining 50 sightings represent intra-atoll movements, in which 22 animals were found on the same islet as the previous record, and 28 on different islets. At Kure, where 140 adult group seals were observed subsequent to tagging, 1927 returns are for the same atoll.

Adult Mortality - Relatively few dead adults were found. On two occasions large sharks with parts of seal in their stomach were caught within a few miles of islands. Two dead adults were found on the beach at Laysan, one in the water off Lisianski, and another on the beach at that island, in the spring of 1963. An adult skeleton was found at Pearl and Hermes in March 1963 and another at French Frigate Shoals ($23^{\circ} 5' N$ Lat, $166^{\circ} 1' W$ Long) in June of that year. Two dead adults were reported from Midway in 1964, one the tagged individual mentioned above. Three dead adults were found at Kure in two years. All were believed victims of vandalism.

Six individuals with shark inflicted injuries were observed at Kure. A seriously wounded adult female was first observed 12 January 1965 (Figure 6). The two large wounds, about 30 cm long and at least 4 cm deep, passed through blubber and into muscle and viscera. The animal was badly

Figure 6: Nature of shark-inflicted wounds to adult female
monk seal, photographed at Kure Atoll, 12 January
1965 by Lt. D. H. Worth, USCG.

emaciated by 20 January and the section between the wounds appeared to be sloughing off. This piece was lost by 20 February and the entire area was covered with a large fatty scab. The wounds appeared healed by 14 March, but reopened in early April. When last observed this animal was listed as "wounded" by Coast Guard personnel on 24 April. An adult found in November 1963 had a large bite-shaped section missing from the lower left side. A subadult tagged in October 1963 had a recent wound about 60 cm long on its dorsum. A year later this wound was only partially healed, and it did not close completely until February 1965. A female found with a new pup early in 1964 was alone two weeks later and her venter was covered with fresh bleeding slashes 20 to 25 cm long and about 2.5 cm deep. The pup was presumed a shark victim. In March 1964 a subadult was found with severe slash wounds to its left fore flipper and adjacent body regions. During the summer this seal spent much of its time on the beach in the sun, and the badly damaged tissue gradually dried up and was lost along with phalanges and metacarpals. By October of that year skin had completely covered the stump.

During a fight between three males one of them received a bite just over a fore flipper which removed a piece of flesh about 9 cm in diameter. Star-shaped scars observed in several animals may have resulted from tissue regeneration in such a bite wound. Several other adults were observed with a variety of circular and slash-shaped scars.

Food Habits - On two occasions recognizable food items were found regurgitated in regularly used seal wallows, and the contents of three stomachs were examined. Two stomachs contained large numbers of cestodes

and nematodes, a few cephalopod beaks, and teleost bones. A third, in addition to nematodes and cestodes, contained the remains of several spiny puffers (Tetraodontidae), a goatfish (Mullidae), several octopuses (Octopus sp.) and several morays (Muraenidae). Regurgitated items included five octopuses, the largest with a tentacle spread of about 60 cm, eight wrasses (Labridae), a parrot fish (Scaridae) about 46 cm long, and a moray about 1.5 m long.

An adult was observed as it caught silvery fish about 28 cm long in shallow water off the beach. It submerged for periods of 95 to 110 seconds. The head was raised out of the water and tilted back while the animal chewed, and occasionally the food was flipped about in the mouth. Three fish were caught and eaten in a ten minute period.

DISCUSSION

The total number of monk seals now tagged, including 129 tagged by Kenyon and Rice (per. comm.), is 504, or one half to one third of the estimated total population (Kenyon and Rice, 1959; Rice, 1960). Only 6 of the 205 animals tagged at Kure are known to have lost tags, and only 9 adult group animals were not subsequently recorded. These data suggest that tag loss is minimal.

The historical data from the last century suggest that the monk seal was nearly exterminated by about 1870 (see Kenyon and Rice, 1959 for summary). Very few animals were seen in the Leewards between 1882 and 1923, and indeed even into the 1950's. Since this latter period there have been 12 independent counts of the herd at Laysan, 9 at Lisianski, and 6 at Pearl and Hermes Reef. Information gathered by the Survey over

a two year period at Kure indicates that several factors must be considered in censusing the monk seal. The number of individuals on the beach at any one time may be affected by season, weather extremes, and time of day, but no known rule can be applied with assurance to any set of circumstances. Pups can swim at birth and may go out into shallow water with the female within two weeks, and thus could be missed on a beach count. The low returns (1) of 56 pups tagged at Kure strongly suggest that pups leave the island within two months of parturition and do not return for several years. There is a tendency for fewer seals to be present on the beach during the day in the warmer months from May through October. In general the animals avoid high temperatures, high winds, and driving rain, apparently preferring to be in the water during weather extremes. Weather data are available for each of the days on which seals were counted at Kure, and there is little apparent correlation, with one exception, between weather conditions and numbers present on the beach. The peaks in December 1964 and January 1965 are related to a severe storm in December which obliterated all the sandspits west of Green Island which are normally favorite hauling grounds. These sandspits were reformed by March 1965, and thus this does not explain the peak in that month. There are usually more animals on the beaches at night than in the day. Human disturbance at Midway Island may have reduced the herd even further from that previously estimated (Kenyon and Rice, 1959; Rice, 1960). Construction of the Coast Guard facility at Kure Atoll, with a concomitant increase in human disturbance to the resident herd, may have reduced the number of animals which haul out on Green Island, but lumping Green Island counts

with those available for the sandspits west of the island gives a figure which compares favorably with censuses made on the island before construction of the facility.

Calculations performed on the censuses taken since 1956 suggest mean populations of 230 (SD 32) for Laysan, 182 (SD 42) for Lisianski, and 193 (SD 62) for Pearl and Hermes Reef. The large standard deviations reflect the great variability observed in the counts. However, as natality and mortality rates are apparently low for this species (see Kenyon and Rice, 1959; Rice, 1960; and Wirtz, 1968), and there is little evidence for inter-atoll movement, it seems reasonable to accept the high counts made during the last ten years as estimates of the adult group utilizing these three islands, or 288 for Laysan, 247 for Lisianski, and 286 for Pearl and Hermes.

The mean percentage of tagged seals observed during 70 counts suggests that a very small percentage of the tagged portion of the herd can be found on land at any given time. The assumption is made that the tagged animals are distributed at random within the population of seals utilizing Kure Atoll, and that there is little turnover. If these assumptions are met, then, on the average, the number of seals seen on the beach during any one census is less than 10 percent of the resident herd. The mean number of adult group animals observed for the 70 counts is 25, suggesting a total population of 250 adult group seals. Extending this theory to counts available for three other islands suggests populations of 2300 for Laysan, 1820 for Lisianski, and 1930 for Pearl and Hermes. On the basis of this calculation the estimate of the world population would be

raised to 13,500 adult group animals.

There is little actual evidence that the tagged seals are distributed at random within the atoll. However, if tagged seals do not mix randomly through the population, that is if each individual tends toward exclusive use of a given area, then an excessively high percentage of tagged individuals would be expected. As this was not the case, the estimate tends to be conservative. If the tagging experience caused the animal to leave the atoll the estimate would be biased in the opposite direction. Repeat observations of all but nine tagged animals rule out this factor. In spite of the fact that movement is poorly documented it must be remembered that observations on the uninhabited islands of Laysan, Lisianski, and Pearl and Hermes are extremely scarce. The documentation of any inter-atoll movement must then be largely due to chance, and one should probably expect more than has been reported. The mean percentage of new adult group animals observed for 22 months is 47.2 (SD 21.6). This means that anywhere from 25 to 69 percent of the adult group animals observed in a given month were not seen during the previous one. The 140 adult group seals which were observed in more than one month at Kure had a collective total of 310 absences from 1 to 12 months in length. The mode of these absences is one month and the median two.

The limited movement recorded, the percentage of new individuals, and the length of absences suggest a slow steady turnover in the composition of the adult group utilizing a given island. This may be a cycling through all utilized Leeward islands or primarily exchange between two or

three islands. Animals occasionally seen among the main Hawaiians may represent stragglers at the periphery of this cycling, or those driven off course by some weather, wind, or current condition. The mean adjusted percentage of tagged adult group observed per census at Kure may be a better representation of the actual number of adult group seals utilizing the atoll at any given time. Calculations using this figure suggest that the mean size of the adult group using Kure at any one time is 106.

The large standard deviations obtained for all population calculations emphasize the great variability in the data. All indications are that only a small percentage of the adult group utilizing Kure at a given time are on the beach on any given day. This, plus the evidence assembled in support of population turnover suggest that all estimates of the total number of Hawaiian monk seals based upon actual counts are low. The adjustment factor lies somewhere between two and ten. Present data are insufficient to further refine the estimate. The true population size may explain the apparent dissolution of tagged seals into the population, when the rate of loss of tags seems low, and does not satisfactorily explain the disappearance of tagged animals. The postulated population size may also explain why it was, or may have been, possible to kill large numbers of monk seals in the middle of the last century (see Bailey, 1952; Kenyon and Rice, 1959). The apparently rapid comeback made by the species in the face of a low reproductive rate may be partly due to an increase in the frequency of censuses during the last ten years. Only an intensive program of tagging and recovery will answer the questions now raised con-

cerning the population dynamics of the Hawaiian monk seal.

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While various Survey members participated in the tagging and censusing, Robert R. Fleet, Cameron B. Kepler, and Dennis L. Stadel played particularly significant roles in the collection of data at Kure Atoll.

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Table 2: Census data on monk seals, Green Island, Kure Atoll.

Column 1 - adult group seals seen; 2 - tagged adult group seals seen; 3 - adult group seals tagged to date; 4 - percent tagged adult group seals seen; 5 - adjusted percent tagged adult group seals seen; 6 - different individuals seen this month; 7 - percent total tagged seen in this month; 8 - adult group seen previous month; 9 - new adult group for this month; 10 - percent new adult group seen = turnover.

Date	1	2	3	4	5	6	7	8	9	10
1 Oct. 1963	22	3	30	10.0	10.0	60	80.0	17	43	71.6
6 Oct.	23	9	52	17.3	15.0					
16 Oct.	24	7	53	13.2	11.7					
25 Oct.	8	3	72	4.2	5.0					
31 Oct.	15	4	73	5.5	6.7					
1 Nov. 1963	13	3	75	4.0	8.6	35	44.3	25	10	28.5
7 Nov.	9	5	79	6.3	14.3					
12 Dec. 1963	29	11	80	13.8	73.3	15	18.7	5	10	66.6
22 Dec.	23	5	80	6.2	33.3					
14 Jan. 1964	34	11	80	13.8	52.4	21	26.2	5	16	76.1
28 Jan.	22	11	80	13.8	52.4					
3 Feb. 1964	24	6	80	7.5	13.3	45	56.2	13	32	71.1
18 Feb.	32	8	80	10.0	17.8					
5 March 1964	27	18	84	21.4	29.5	61	67.7	35	26	42.6
16 March	23	9	89	10.1	14.8					
30 March	18	12	90	13.3	19.7					
11 April 1964	22	12	92	13.0	27.9	43	46.7	25	18	41.8
* May 1964			92			30	32.6	14	16	53.3
8 June 1964	23	8	107	7.5	29.6	27	25.2	13	14	51.8
24 June	12	4	107	3.7	14.8					
3 July 1964	22	8	107	7.5	16.3	49	45.8	16	33	67.3
10 July	26	12	107	11.2	24.5					
20 July	19	4	107	3.7	8.2					
27 July	26	11	107	10.3	22.4					
5 Aug. 1964	12	7	107	6.5	22.6	31	29.0	19	12	38.7
13 Aug.	23	10	107	9.3	32.3					
20 Aug.	20	3	107	2.8	9.7					
28 Aug.	9	1	107	0.9	3.2					
4 Sept. 1964	9	1	107	0.9	5.6	18	16.8	6	12	66.6
11 Sept.	11	2	107	1.9	11.1					
18 Sept.	19	1	107	0.9	5.6					
25 Sept.	7	1	107	0.9	5.6					
1 Oct. 1964	9	3	107	2.8	9.7	31	29.0	7	24	77.4
9 Oct.	2	0	107	0.0	0.0					
15 Oct.	4	0	107	0.0	0.0					
23 Oct.	8	8	107	7.5	25.8					
29 Oct.	7	2	107	1.9	6.4					
6 Nov. 1964	13	6	108	5.6	9.2	65	57.0	24	41	63.0
13 Nov.	17	7	109	6.4	10.8					
22 Nov.	18	10	114	8.8	15.4					
28 Nov.	23	9	114	7.9	13.8					
5 Dec. 1964	21	8	114	7.0	11.3	71	62.3	57	14	19.7
12 Dec.	16	6	114	5.3	8.4					
19 Dec.	73	28	114	24.6	39.4					
26 Dec.	78	31	114	27.2	43.7					
31 Dec.	21	12	114	10.5	16.9					

Date	1	2	3	4	5	6	7	8	9	10
9 Jan. 1965	16	9	114	7.9	10.1	89	66.4	61	28	31.4
16 Jan.	74	43	134	32.1	48.3					
23 Jan.	12	3	134	2.2	3.4					
30 Jan.	8	6	134	4.5	6.7					
6 Feb. 1965	22	10	134	7.5	23.8	42	31.1	40	2	4.7
13 Feb.	9	7	134	5.2	16.7					
20 Feb.	34	15	135	11.1	35.7					
27 Feb.	22	9	135	6.7	21.4					
6 March 1965	49	16	135	11.8	19.0	84	60.9	38	46	54.7
14 March	29	9	135	6.7	10.7					
21 March	68	35	136	25.7	41.7					
27 March	35	8	138	5.8	9.5					
3 April 1965	42	19	148	12.8	34.5	55	36.9	51	4	7.2
10 April	54	25	148	16.9	45.4					
18 April	51	31	149	20.8	56.4					
24 April	24	24	149	16.1	43.6					
8 May 1965	47	27	149	18.1	58.7	46	30.9	32	14	30.4
15 May	55	30	149	20.1	65.2					
22 May	21	14	149	9.4	30.4					
29 May	19	14	149	9.4	30.4					
5 June 1965	28	8	149	5.4	33.3	24	16.1	15	9	37.5
12 June	35	16	149	10.7	66.7					
26 June	28	7	149	4.7	29.2					
10 July 1965	25	9	149	6.0	64.3	14	9.4	9	5	35.7
24 July	20	2	149	1.3	14.3					

* no counts made in this month

Table 3: Recent population estimates for Laysan Island,
Lisianski Island, and Pearl and Hermes Reef.
Total to left of virgule, pups to right.

Month	Year	Laysan	Lisianski	Pearl-Hermes	Authority*
April	1957	233/19	256/15		1
May	1957			290/33	1
June	1957	177/			2
May	1958	326/46			3
June	1958		281/34	338/52	3
April	1959	223/			4
July	1959	234/			5
March	1961	229/23	¹⁷² 173 /1		6
Sept.	1961	²²⁰ 225 /65			5
June	1962	261/23			7
March	1963		210/1	201/0	8
Dec.	1963	179/			
March	1964	³¹⁰ 312 /22	180/7	121/0	8
Aug.	1964		144/1	125/2	8
Sept.	1964	252/0	121/0		8
March	1965	243/31	187/15	175/2	8
July	1965		161/0		8
Aug.	1965	210/15			8
June	1966	242/68	157/36		8

*1) Kenyon and Rice, 1959; 2) Woodside, ~~1957~~¹⁹⁶¹; 3) Rice, 1960;
4) Smythe, 1960; 5) Udvardy, 1961; 6) Woodside and Kramer,
1961; 7) Kramer and Beardsley, 1962; 8) this paper.

Oct	1966	120/31	111/9	8
March	1967		132/	
June	1967	89/27	128/12	8
Aug.	1967			
Sept	1967			

Figure 4: Monthly distribution of percentage of new adult
group individuals observed.

